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FIRST REPORT OF THE THUNDERSTORM COMMITTEE.

ON THE PHOTOGRAPHS OF LIGHTNING FLASHES
Received by the ROYAL METEOROLOGICAL SOCIETY.

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Price One Shilling.

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THUNDERSTORMS

JOHN TAYLOR AND SONS, LTD., LONDON

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IN the month of June 1887, the Committee issued about 200 circulars to the Secretaries of Photographic Societies in various parts of Europe and America, and also to other likely persons, requesting them to furnish the Royal Meteorological Society with photographs of Lightning flashes.

About 60 photographs of Lightning flashes were received in answer to this invitation; and these were exhibited at the Meeting of the Society in March 1888, where they received much attention.

From the evidence now obtained it is evident that Lightning assumes various typical forms, under conditions which are at present unknown.

The following appear to be some of the most typical forms of Lightning flashes :—

1. *Stream Lightning*, or a plain, broad, rather smooth streak of light.—Only two or three specimens of this form have been received. The Committee are disposed to consider this a distinct type of a single stream-like character, without distinct irregularities or branches, and not merely the result of bad focussing, because, as in the illustration here given, other objects—such as the trees—are extremely sharp.

An example is given in No. 1 of Plate III. from a photograph taken by Mr. L. S. Clarke, Pittsburg, Pennsylvania, April 1886.

2. *Sinuuous Lightning*, when the flash keeps in some one general direction, but the line is sinuous, bending from side to side in a very irregular manner. This is by far the commonest type.

It is very noticeable that the thickness of the line varies during the course of discharge. Sometimes the thinnest part of the white streak is the highest, and the flash appears to get thicker as it approaches the earth; at other times a flash in the air begins thin, broadens out in the middle, and fines away again at the further extremity.

The Committee can offer no explanation of this at present, but they would call attention to the fact that in some photographs of electric sparks taken

from an induction coil, those of high tension are thinner than those of low tension.

An excellent example of this sinuous type is given in No. 4 of Plate III. from a photograph taken by Mr. L. S. Clarke from the top of the Alleghany Mountains on August 2nd, 1887.

3. *Ramified Lightning*, in which part of the flash appears to branch off from the main streak like the fibres from the root of a tree. Of course there is no evidence as to whether these fibres branch off from, or run into, the main flash.

A beautiful illustration is given in No. 2 of Plate III. from a photograph by Mr. E. S. Shepherd, in London, at 9 p.m. on August 17th, 1887.

4. *Meandering Lightning*.—Sometimes the flash appears to meander about in the air without any definite course, and forms small, irregular loops. The thickness of the same flash may vary considerably in different parts of the course, as mentioned above; and a flash may go pretty straight in one portion of its path, but meander considerably in another.

An example is given in No. 3 of Plate III. from a photograph by Mr. J. Gray, at Brixton, at 9 p.m. on August 17th, 1887. This is the same storm as that which produced the ramified flash shown in No. 2, and one of the fibres of that flash is curiously meandering.

5. *Beaded or Chapletted Lightning*.—Sometimes a series of bright beads appear in the general white streak of Lightning on the photographic plate. Occasionally these brighter spots appear to coincide with bends in a meandering type, as in No. 3, Plate III.; but often the beads appear without any evident looping of the flash.

But as a flash is moving in space, while two directions only can be shown on the plane of the paper, there is every reason to believe that the brighter spots on the positive picture may be points where the flash was zig-zagging, either directly towards, or away from the observer, and thereby giving a somewhat longer exposure to these spots.

It may be remarked that the photograph of the spark derived from a large influence machine by Mr. Wimshurst and engraved in *Engineering* for April 27th, 1888, p. 420, shows distinct beading in places. This is reproduced in fig. 1a through the courtesy of the publisher of *Engineering*.

6. *Ribbon Lightning*.—Nearly one-sixth of the photographs received by the Society show flashes exhibiting more or less of a ribbon-like form. One edge of the ribbon is usually much whiter and firmer than the other.

Occasionally in the same picture, some flashes appear normal and others ribboned; but the flashes in a picture need not have occurred simultaneously. The Committee have not yet in their possession any conclusive evidence as to whether the same flash may be normal in one portion, and ribboned in another portion of its course.

In one picture there is a bright streak on the top of the flash; then about $\frac{1}{8}$ th inch of ribbon-like light, the folds following the sinuosities of the bright streak; then a dark band, parallel to, and following, every irregularity of the bright streak; and then nearly another $\frac{1}{8}$ th inch of ribbon-like light. In

another picture a very thin beaded flash has a precisely similar beaded streak, rather fainter than itself, running parallel to it, at a distance of about $\frac{1}{16}$ th inch on the paper.

It might be suggested that the second fainter image was formed by internal reflection from the back surface of the glass plate; but it should be noticed that sometimes very thin flashes, which are not particularly bright, are so duplicated.

A far more probable cause is the double image formed by the internal reflections of doublet photographic lenses. All doublets are essentially two meniscus lenses, mounted with their concave surfaces facing one another. The greater portion of a strong point of light, passing through both lenses, forms the usual image on the plate; but a smaller portion is reflected from the concave surface of the rear meniscus on to the concave surface of the front lens, and from thence back through the rear lens to the sensitive plate. The amount of displacement depends on the angle formed between the direction of the bright point and the optical axis of the lens.

Mons. C. Moussette of Paris showed the writer of this Report some photographs of the sun in which this double reflection image was very conspicuous; and there is not the slightest doubt that some Lightning flashes are bright enough to give this secondary image. Mons. Moussette also showed the writer the photograph of a flash in which the centre of the flash was whitest, with a darker edge on either side. This may have been produced either by double reflection from the lens, or by internal reflection from the back of the glass plate. Two bands of light—the primary and secondary images—slightly overlapping, would form an extra bright band where the overlap took place.

In the majority of cases, the folds of the ribbon formation are most obvious when the course of the flash is square to the width of the folds, and they are but slightly pronounced when in a line with them. This would suggest the idea of a shaking of the camera in the direction of the folds of the ribbon; but if this is so, the duration of a Lightning flash must be much longer than is usually supposed.

The Committee hope to have the opportunity of making some experiments on the photography of sparks from a coil or electrical influence machine.

The Committee in the meantime must defer expressing an opinion as to whether Lightning ever really takes a ribbon-like form till further evidence is available; but would point out that both sources of error—the duplication of the image either by reflection inside the lens, or by reflection from the back of the plate—would be avoided by the use of single lenses, and of paper instead of glass supported films. The Committee also forbear for the present from publishing a reproduction of a ribbon-like flash, till they are satisfied that such a form of lightning really exists; and that the whole appearance is not due to photographic causes.

Anomalous Appearance.—In one picture sent, by Mr. Shepherd, there are five ordinary white flashes and one dark streak of precisely the same character as the bright streaks. Mons. Moussette has suggested that this may be the result of a very bright flash, so over-exposing the plate as to produce the

well known inversion of a negative by over-exposure, as when the ball of the sun appears black on the positive print, instead of white. This is no doubt a possible explanation; but the Committee would like further examples of this same appearance of dark flashes before expressing an opinion on the matter.¹

Pictorial Representation of Lightning.—The Committee wish to call attention to the fact that there is not the slightest evidence in the photographs of Lightning flashes of that angular zig-zag or forked form so commonly seen in pictures.

In connection with this, they would call attention to a remarkable paper communicated to the British Association in 1856, by James Nasmyth, F.R.S. (*Report Brit. Assoc.* 1856, p. 14). Mr. Nasmyth says that he has never seen forked Lightning such as fig. 1, and asserts that "the true natural form of a primitive flash of Lightning appears to Mr. Nasmyth to be more correctly represented by an intensely crooked line, as indicated in fig. 2; and on several occasions he has observed it to assume the forked or branched form indicated in fig. 3, but, as before said, never in the zig-zag dovetail of fig. 1."

The photographic reproductions of Lightning flashes appended to this Report (Plate III.) are a striking commentary on Mr. Nasmyth's accuracy, both as an observer and as an artist.

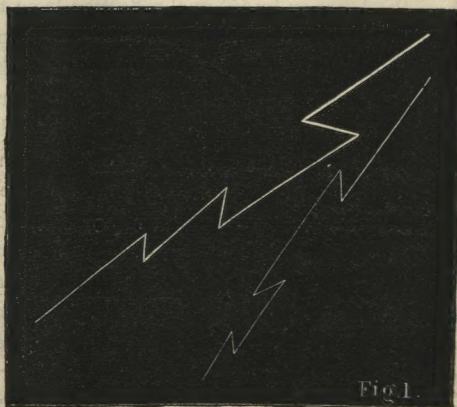


FIG. 1.—Artists' Lightning, after Nasmyth.

¹ It is to be remembered that where the flashes cross each other, and consequently produce a double exposure of those parts of the sensitive plate, no darkening is observable.

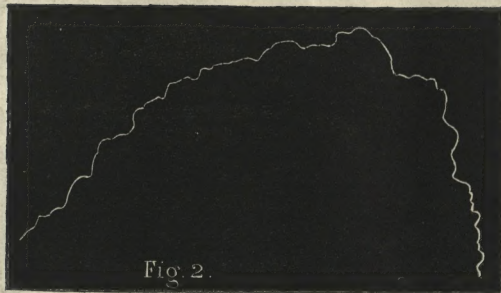


FIG. 2.—Natural Lightning, according to Nasmyth.

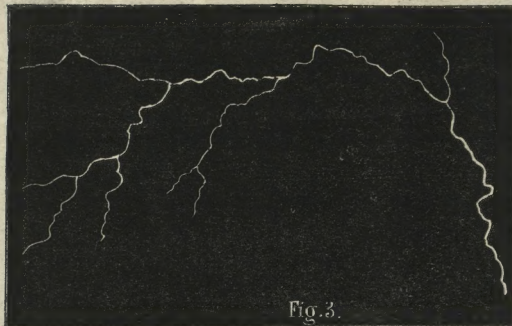


FIG. 3.—Branched Lightning, according to Nasmyth.

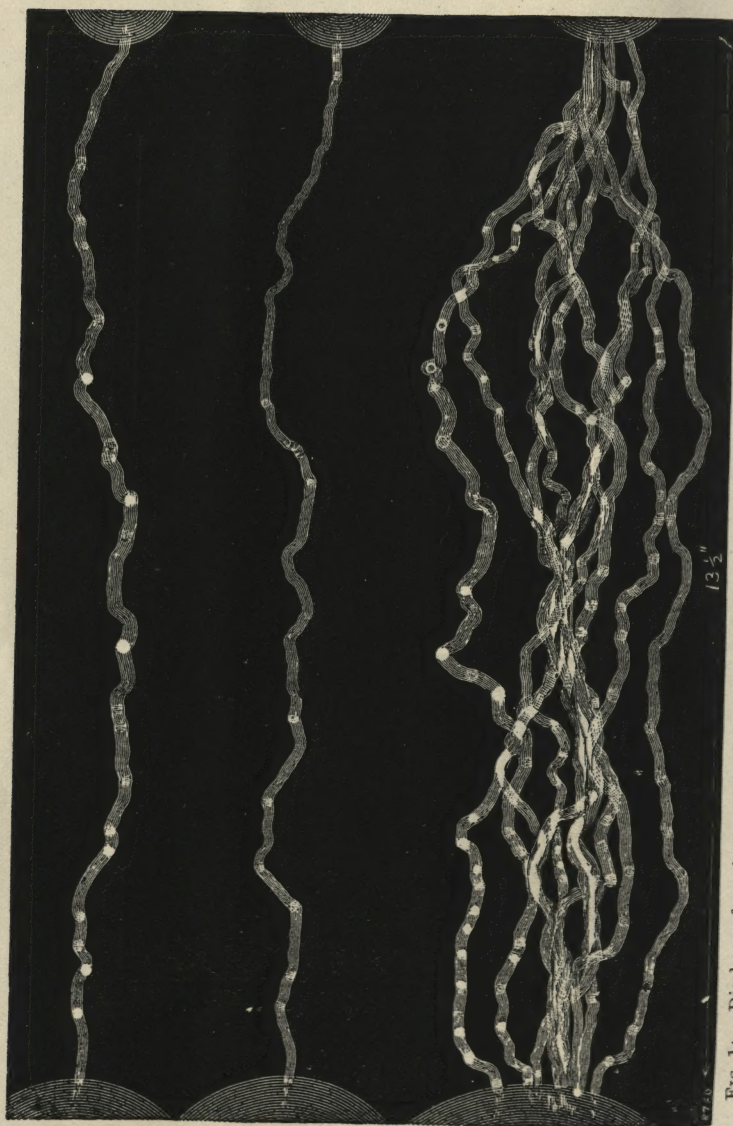


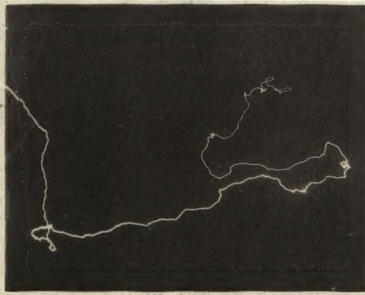
FIG. 1A.—Discharge from large electrical influence machine, by Mr. Wimshurst, showing bright beads in the streaks of light.



1 *Stream.*



2 *Ramified.*



3. *Meandering.*



4. *Sinuuous.*

